Interpreting CMMI High Maturity for Small Organizations

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213

Robert W. Stoddard

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Agenda

Why This Workshop?

Introduction to CMMI Process Performance Models and Baselines

Contrasting Large vs Small Organizational Settings (group exercises)

1. Project Lifecycle Needs
2. Performance Outcomes ("y's")
3. "x" Factors (controllable and un-controllable)
4. Usage of Models
5. Analytical Methods
6. Training and Deployment
7. Sponsorship and Participation

Next Steps

Why This Workshop?

CMMI Process Performance Models and Baselines are not clearly understood

- *historical misconceptions resulting in lackluster results*
- *opportunity to leverage proven Six Sigma toolkit*

Confusion exists regarding the applicability of CMMI Process Performance Models and Baselines to small organizational settings

Small settings in this workshop refers to projects of 3-9 months duration with 3-10 staff

Performance results must be elevated above compliance to a given model

INTRODUCTION TO CMMI PROCESS PERFORMANCE MODELS AND BASELINES

OPP SP 1.1 Select Processes

Select the processes or subprocesses in the organization's set of standard processes that are to be included in the organization's process-performance analyses.

Select processes/subprocesses that will help us understand our ability to meet the objectives of the organization and projects, and the need to understand quality and process performance. These subprocesses will typically be the major contributors and/or their measures will be the leading indicators.

Excerpted from Tutorial: "If You're Living the "High Life", You're Living the Informative Material" presented at the SEPG North America, by Rusty Young, Mike Konrad and Bob Stoddard, March, 2008

OPP SP 1.2 Establish Process-Performance Measures

Establish and maintain definitions of the measures that are to be included in the organization's process-performance analyses.

Select measures, analyses, and procedures that provide insight into the organization's ability to meet its objectives and into the organization's quality and process performance. Create/update clear unambiguous operational definitions for the selected measures. Revise and update the set of measures, analyses, and procedures as warranted. In usage, be sensitive to measurement error. The set of measures may provide coverage of the entire lifecycle and be controllable.

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OPP SP 1.3 Establish Quality and Process-Performance Objectives

Establish and maintain quantitative objectives for quality and process performance for the organization.

These objectives will be derived from the organization’s business objectives and will typically be specific to the organization, group, or function. These objectives will take into account what is realistically achievable based upon a quantitative understanding (knowledge of variation) of the organization’s historic quality and process performance. Typically they will be SMART and revised as needed.

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OPP SP 1.4 Establish Process-Performance Baselines

Establish and maintain the organization's process-performance baselines.

Baselines will be established by analyzing the distribution of the data to establish the central tendency and dispersion that characterize the expected performance and variation for the selected process/subprocess. These baselines may be established for single processes, for a sequence of processes, etc. When baselines are created based on data from unstable processes, it should be clearly documented so the consumers of the data will have insight into the risk of using the baseline. Tailoring may affect comparability between baselines.

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OPP SP 1.5 Establish Process-Performance Models

Establish and maintain the process-performance models for the organization's set of standard processes.

Rather than just a point estimate, PPMs will address variation in the prediction. PPMs will model the interrelationships between subprocesses including controllable/uncontrollable factors. They enable predicting the effects on downstream processes based on current results. They enable modeling of a PDP to predict if the project can meet its objectives and evaluate various alternative PDP compositions. They can predict the effects of corrective actions and process changes. They can also be used to evaluate the effects of new processes and technologies/innovations in the OSSP.

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QPM SP 1.1 Establish the Project's Objectives

Establish and maintain the project's quality and process-performance objectives.

These objectives will be based on the organization's quality and process performance objectives and any additional customer and relevant stakeholder needs and objectives. These objectives will be realistic (based upon analysis of historical quality and process performance) and will cover interim, supplier, and end-state objectives. Conflicts between objectives (i.e., trade-offs between cost, quality, and time-to-market) will be resolved with relevant stakeholders. Typically they will be SMART, traceable to their source, and revised as needed.

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QPM SP 1.2 Compose the Defined Process

Select the subprocesses that compose the project's defined process based on historical stability and capability data.

The PDP is composed by:

- selecting subprocesses
- adjusting/trading-off the level and depth of intensity of application of the subprocess(es) and/or resources

to best meet the quality and process performance objectives. This can be accomplished by modeling/simulating the candidate PDP(s) to predict if they will achieve the objectives, and the confidence level of (or risk of not) achieving the objective.

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QPM SP 1.3 Select the Subprocesses that Will Be Statistically Managed

Select the subprocesses of the project's defined process that will be statistically managed.

Subprocesses that are the major contributors to or predictors of the accomplishment of the project's interim or end-state objectives will be selected. Additionally, these need to be suitable for statistical management. Statistically managing the selected subprocesses provides valuable insight into performance by helping the project identify when corrective action is needed to achieve its objectives. Select the attributes that will measured and controlled.

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QPM SP 1.4 Manage Project Performance

Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and identify corrective action as appropriate.

Monitor the project

- Manage stability and capability of selected subprocesses.
- Track quality and process performance data including suppliers'
- Update/calibrate PPMs and predictions based on results to date.
- Identify deficiencies/risks to achieving objectives (e.g., where current performance is outside tolerance intervals, or prediction/confidence intervals are not contained within specification limits).

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QPM SP 2.1 Select Measures and Analytic Techniques

Select the measures and analytic techniques to be used in statistically managing the selected subprocesses.

Identify the measures that will provide insight into the performance of the subprocesses selected for statistical management and the statistical techniques that will be used for analysis. These measures can be for both controllable and uncontrollable factors. Operational definitions will be created/updated for these measures. Where appropriate (i.e., they are critical to meeting downstream objectives), spec limits will be established for the measures.

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QPM SP 2.2 Apply Statistical Methods to Understand Variation

Establish and maintain an understanding of the variation of the selected subprocesses using the selected measures and analytic techniques.

Selected measures for the subprocesses will be statistically controlled to identify, remove, and prevent reoccurrence of special causes of variation, or in other words, stabilize the process. When control limits are too wide, sources of variation are easily masked and further investigation is warranted.

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QPM SP 2.3 Monitor Performance of the Selected Subprocesses

Monitor the performance of the selected subprocesses to determine their capability to satisfy their quality and process-performance objectives, and identify corrective action as necessary.

For a stable subprocess, determine if the control limits (natural bounds) are within the specification limits which indicates a capable subprocess. If it is not, document corrective actions that address the capability deficiencies.

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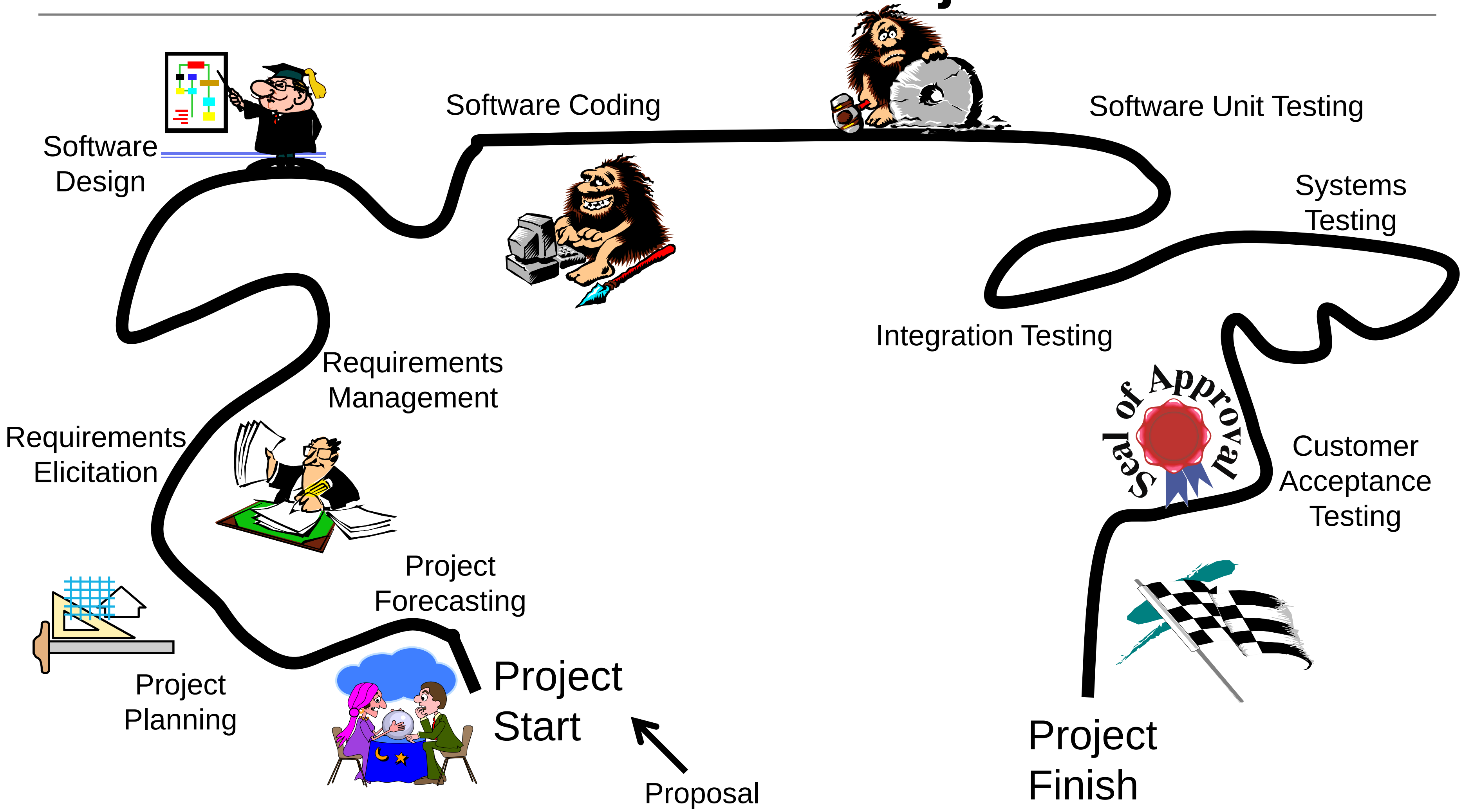
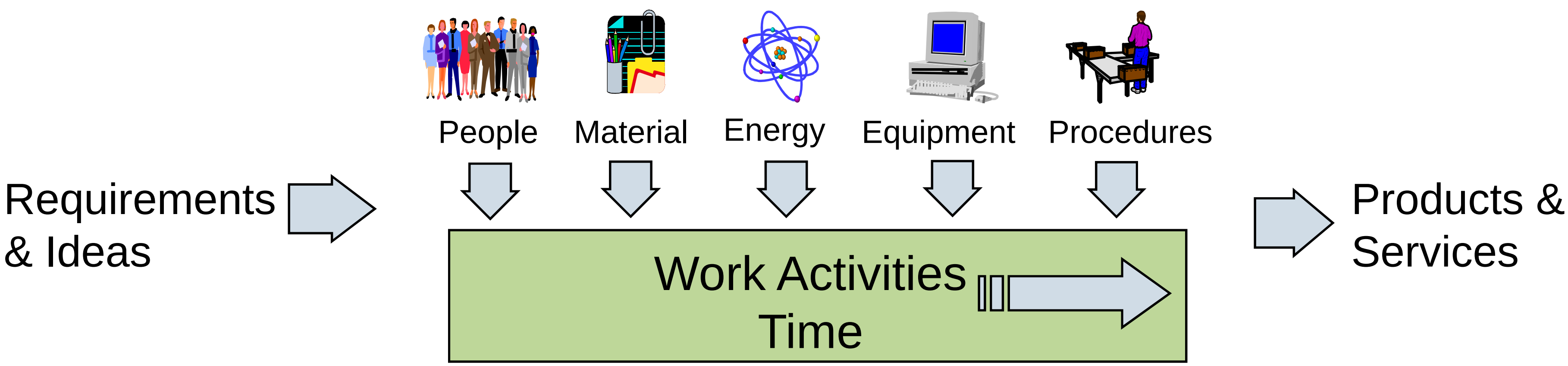
When and Why Do We Need Process Performance Models at the Project Level?



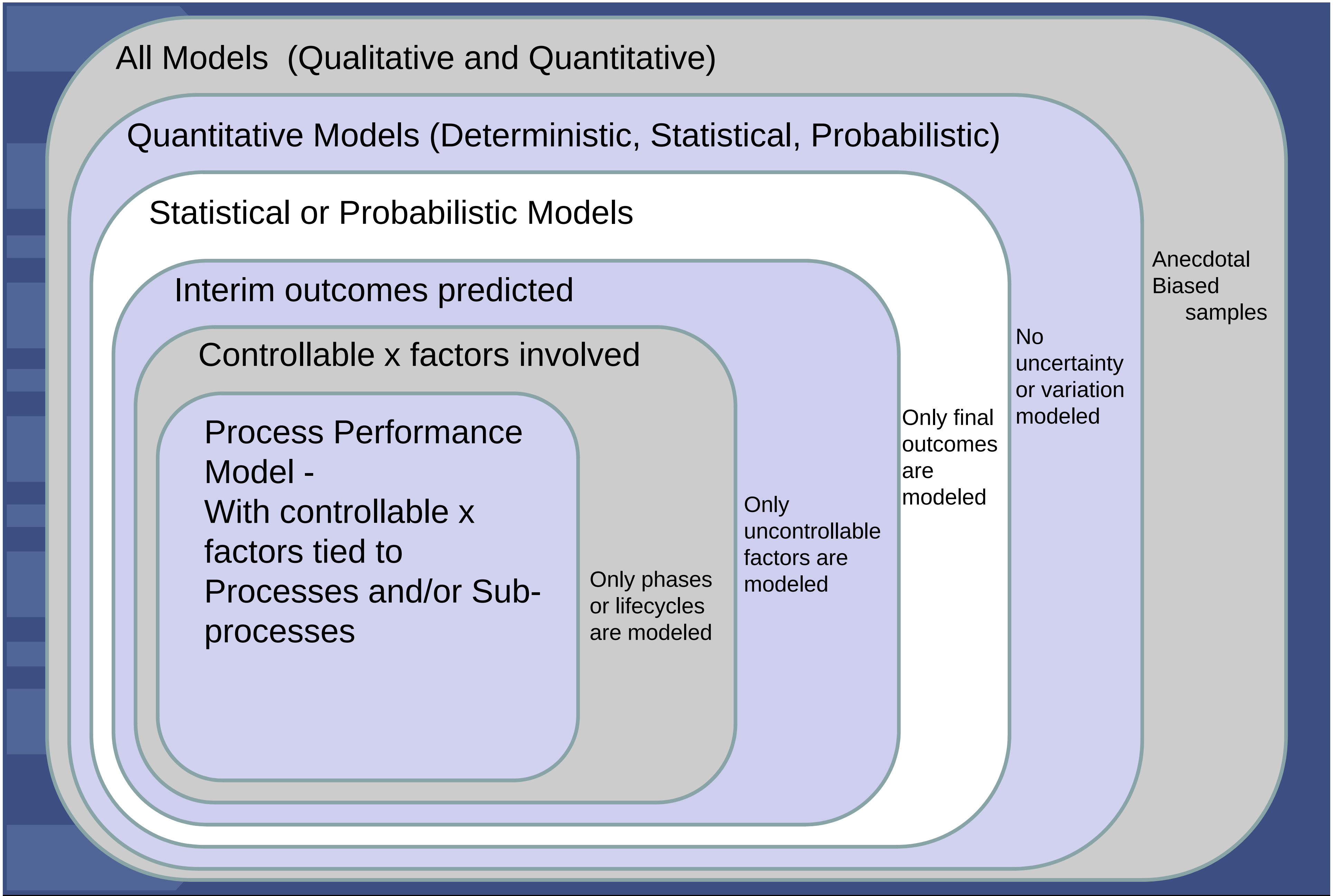
Process Performance Models View Processes Holistically

Processes may be thought of holistically as a system that includes the people, materials, energy, equipment, and procedures necessary to produce a product or service.



Healthy Ingredients of CMMI Process Performance Models

1. Statistical, probabilistic or simulation in nature
2. Predict interim and/or final project outcomes
3. Use controllable factors tied to sub-processes to conduct the prediction
4. Model the variation of factors and understand the predicted range or variation of the outcomes
5. Enable “what-if” analysis for project planning, dynamic re-planning and problem resolution during project execution
6. Connect “upstream” activity with “downstream” activity
7. Enable projects to achieve mid-course corrections to ensure project success


All Models (Qualitative and Quantitative)
Quantitative Models (Deterministic, Statistical, Probabilistic)
Statistical or Probabilistic Models
Interim outcomes predicted
Controllable x factors involved
Process Performance Model - With controllable x factors tied to Processes and/or Sub-processes
Only phases or lifecycles are modeled
Only uncontrollable factors are modeled
Only final outcomes are modeled
No uncertainty or variation modeled
Anecdotal Biased samples

CONTRASTING LARGE VS SMALL ORGANIZATIONAL SETTINGS:

PROJECT LIFECYCLE NEEDS

Project Lifecycle Needs

Large Settings

- Distinct phases and activities performed in specified serial fashion
- Different people or teams involved in the different phases and activities
- Risks during internal hand-offs quite great
- Communication and expectations not matched

Small Settings

- Fluid phases and processes running together
- Same people perform many if not most of the activities
- Risks between external entities are greatest
- Lack of cross training is high risk; depend on specific individuals

Group Exercise #1 (10 minutes)

Within your group, share ideas on what **the most important lifecycle needs and risks** are in your small organizational settings

Record your group ideas on your group flip pad

Prepare to share 3-5 ideas with the audience at large

CONTRASTING LARGE VS SMALL ORGANIZATIONAL SETTINGS:

PERFORMANCE OUTCOMES (Y'S)

Performance Outcomes ("y's")

Large Settings

- Final project quality, schedule and cycle time measures
- Interim outcomes tied to key phase and activity hand-offs
- Communication across groups and geographic locations

Small Settings

- Customer Satisfaction
- Customer Relationship
- Req'ts Completeness and Understanding
- Relationship with suppliers or other subcontractors
- Availability of key staff
- Staff versatility, training
- Staff Productivity, Morale

Performance Outcomes ("y's)

Large Settings

- Final project quality, schedule and cycle time measures

Think of the outcomes that would benefit a small project if they had the ability to predict and re-predict during their short lifecycle to maximize success

locations

Small Settings

- Customer Satisfaction
- Customer Relationship
- Req'ts Completeness and Understanding
- Relationship with suppliers or other subcontractors
- Availability of key staff
- Staff versatility, training
- Staff Productivity, Morale

Group Exercise #2 (10 minutes)

Within your group, discuss the **types of performance outcomes** that your projects, within small settings, are most concerned with.

Document the ideas on your group flip pad

Be prepared to share some of these with the audience at large

CONTRASTING LARGE VS SMALL ORGANIZATIONAL SETTINGS:

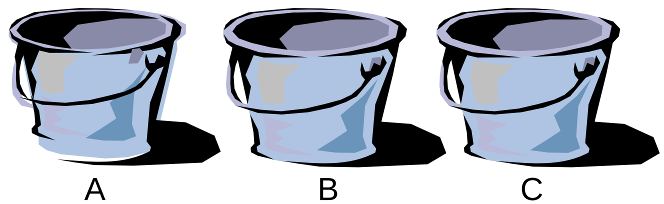
“X” FACTORS (CONTROLLABLE AND UNCONTROLLABLE)

Data Types Determine Which Techniques To Use

Attribute
(aka categorized or discrete data)

Nominal

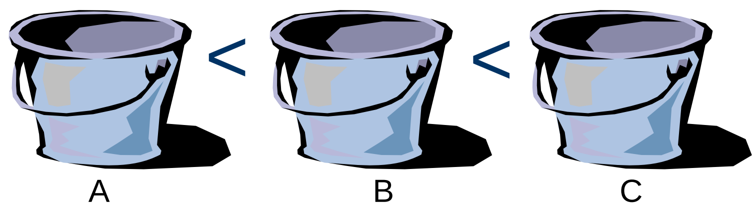
Categorical data where the order of the categories is arbitrary



Examples
Defect types
Labor types
Languages

Ordinal

Nominal data with an ordering; may have unequal intervals



Examples
Severity levels
Survey choices 1-5
Experience categories

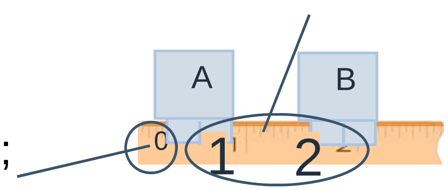
Continuous
(aka variables data)

Interval

Continuous data with equal intervals; may have decimal values

Ratio

Interval data set that also has a true zero point;



Examples
Defect densities
Labor rates
Productivity
Variance %'s
Code size SLOC

ANOVA & Dummy Variable Regression Models

Using these controllable factors…	To predict this outcome!
Type of Reviews Conducted; Type of Design Method; Language Chosen; Types of Testing	Delivered Defect Density
High-Medium-Low Domain Experience; Architecture Layer; Feature; Team; Lifecycle model; Primary communication method	Productivity
Estimation method employed; Estimator; Type of Project; High-Medium-Low Staff Turnover; High-Medium-Low Complexity; Customer; Product	Cost and Schedule Variance
Team; Product; High-Medium-Low Maturity of Platform; Maturity or Capability Level of Process; Decision-making level in organization; Release	Cycle Time or Time-to-Market
Iterations on Req'ts; Yes/No Prototype; Method of Req'ts Elicitation; Yes/No Beta Test; Yes/No On-Time; High-Medium-Low Customer Relationship	Customer Satisfaction (as a percentile result)

Simple and Multiple Regression

Using these controllable factors…	To predict this outcome!
Req'ts Volatility; Design and Code Complexity; Test Coverage; Escaped Defect Rates	Delivered Defect Density
Staff Turnover %; Years of Domain Experience; Employee Morale Survey %; Volume of Interruptions or Task Switching	Productivity
Availability of Test Equipment %; Req'ts Volatility; Complexity; Staff Turnover Rates	Cost and Schedule Variance
Individual task durations in hrs; Staff availability %; Percentage of specs undefined; Defect arrival rates during inspections or testing	Cycle Time or Time-to-Market
Resolution time of customer inquiries; Resolution time of customer fixes; Percent of features delivered on-time; Face time per week	Customer Satisfaction (as a percentile result)

Chi-Square & Logistic Regression

Using these controllable factors…	To predict this outcome!
Programming Language; High-Medium-Low Schedule compression; Req'ts method; Design method; Coding method; Peer Review method	Types of Defects
Predicted Types of Defects; High-Medium-Low Schedule compression; Types of Features Implemented; Parts of Architecture Modified	Types of Testing Most Needed
Architecture Layers or components to be modified; Type of Product; Development Environment chosen; Types of Features	Types of Skills Needed
Types of Customer engagements; Type of Customer; Product involved; Culture; Region	Results of Multiple Choice Customer Surveys
Product; Lifecycle Model Chosen; High-Medium-Low Schedule compression; Previous High Risk Categories	Risk Categories of Highest Concern

Logistic Regression

Using these controllable factors…	To predict this outcome!
Inspection Preparation Rates; Inspection Review Rates; Test Case Coverage %; Staff Turnover Rates; Previous Escape Defect Rates	Types of Defects
Escape Defect Rates; Predicted Defect Density entering test; Available Test Staff Hours; Test Equipment or Test Software Availability	Types of Testing Most Needed
Defect Rates in the Field; Defect rates in previous release or product; Turnover Rates; Complexity of Issues Expected or Actual	Types of Skills Needed
Time (in Hours) spent with Customers; Defect rates of products or releases; Response times	Results of Multiple Choice Customer Surveys
Defect densities during inspections and test; Time to execute tasks normalized to work product size	Risk Categories of Highest Concern

"x" Factors

Large Settings

- Reqts Volatility
- Architecture and Design complexity
- Code complexity
- Test Coverage
- Test Execution
- Avg experience level of team
- Modern development tools

Small Settings

- People attributes such as:
  - Personal productivity
  - Individual interruptions
  - Teaming Attributes
  - Conflict resolution
  - Domain experience of key staff
  - Knowledge sharing methods
  - Daily communications

“x” Factors

Large Settings

- Reqts Volatility
- Architecture and Design

Think of the “x” factors related to individual and small team activities that drive performance outcomes

- Test Execution
- Avg experience level of team
- Modern development tools

Small Settings

- People attributes such as:
  - Personal productivity
  - Individual interruptions
  - Teaming Attributes
  - Conflict resolution
  - Domain experience of key staff
  - Knowledge sharing methods
  - Daily communications

Group Exercise #3
(10 minutes)

Within your group, discuss the **types of "x" factors** that your projects within small settings would be most affected by. These should be factors related to the people, process, tools, technology or environment that most affect or determine the performance outcomes.

Document the ideas on your group flip pad. Be sure to distinguish the controllable vs un-controllable "x" factors.

Be prepared to share some of these factors with the audience at large

CONTRASTING LARGE VS SMALL ORGANIZATIONAL SETTINGS:

USAGE OF MODELS

Usage of Models

Large Settings

- Statistical management of key subprocesses usually related to key handoffs in large teams
- Predict outcomes at key milestones or end of key phases
- Support significant CAR or OID activity

Small Settings

- Provide updates on impacts of key technology or people issues
- Predict updated impacts on key risks based on real-time information or events
- Predict "what-if"'s for real-time replanning during weekly if not daily intervals
- Predict abilities on a feature by feature basis

Group Exercise #4 (10 minutes)

Within your group, discuss the **usage of process performance models** that your projects within small settings would most likely use. Be sure to note the rationale for the analytical models identified.

Document the model ideas on your group flip pad

Be prepared to share some of these with the audience at large

CONTRASTING LARGE VS SMALL ORGANIZATIONAL SETTINGS:

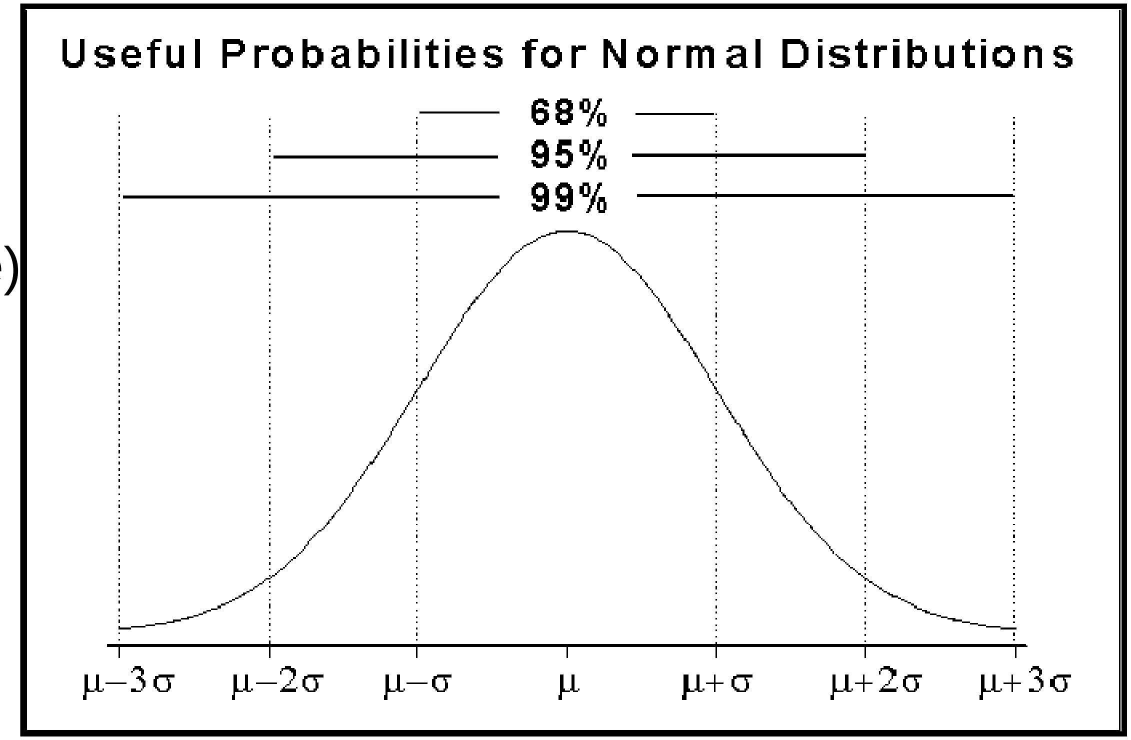
ANALYTICAL METHODS

What Is a Statistic?

A summary or characterization of a distribution (i.e., a set of numbers)

A characterization of a central tendency (e.g., mean, median, and mode)

A characterization of dispersion (e.g., variance, standard deviation, interquartile range, and range)



Central Tendency and Dispersion

Central tendency implies location:

- middle of a group of values
- balance point
- examples include mean, median, and mode

Dispersion implies spread:

- distance between values
- how much the values tend to differ from one another
- examples include range and (sample) standard deviation

These two are used together to understand the baseline of a process-performance factor and outcome.

Hypothesis Testing: To Understand and Compare Performance

A formal way of making a comparison and deciding whether or not the difference is significant is based on statistical analysis.

Hypothesis testing consists of a null and alternative hypothesis:

- The null hypothesis states that the members of the comparison are equal; there is no difference (a concrete, default position).
- The alternative hypothesis states that there is a difference; it is supported when the null hypothesis is rejected.

The conclusion either rejects or fails to reject the null hypothesis.

Understanding the null and alternative hypotheses is the key to understanding the results of statistical prediction models.

Formally Stating a Hypothesis

Average productivity equals 100 source lines of code (SLOC) per person week:

- Null: Average productivity is equal to 100 SLOC per person week.
- Alternative: Average productivity is not equal to 100 SLOC per person week.

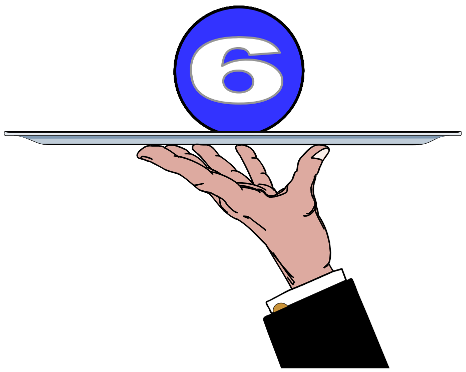
A refinement of these hypotheses are as follows:

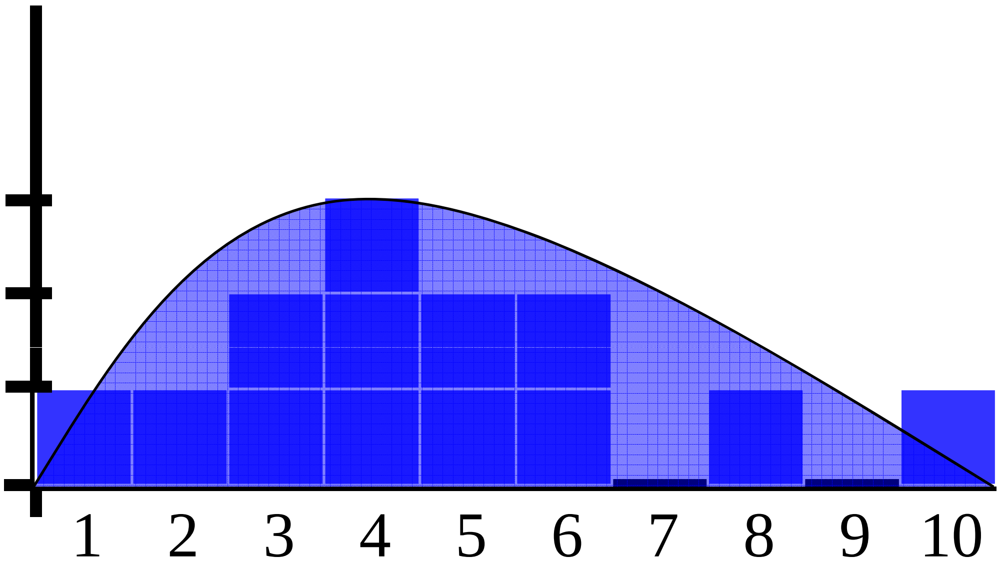
- Null: Average productivity is equal to 100 SLOC per person week.
- Alternative: Average productivity is less than 100 SLOC per person week.

Generally, the alternative hypothesis is the difference (e.g. improvement or performance problem) that you seek to learn about.

The null hypothesis holds the conservative position that apparent differences can be explained by chance alone. The phrase “is equal to” will generally appear in the null hypothesis.

We Must Understand Distributions – They are Key to Informed Decisions



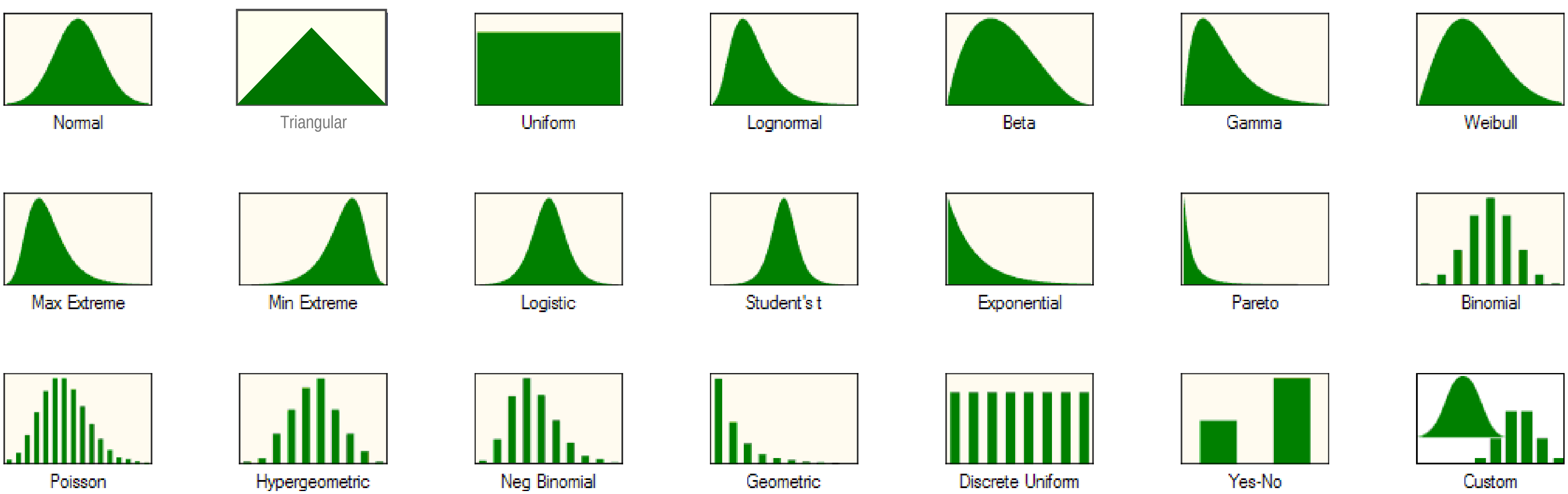


Distributions Describe Variation in Process Factors

Populations of data may be viewed as distributions in statistical procedures:

- expressed as an assumption for the procedure
- can be represented using an equation

The following are examples of distributions you may come across:

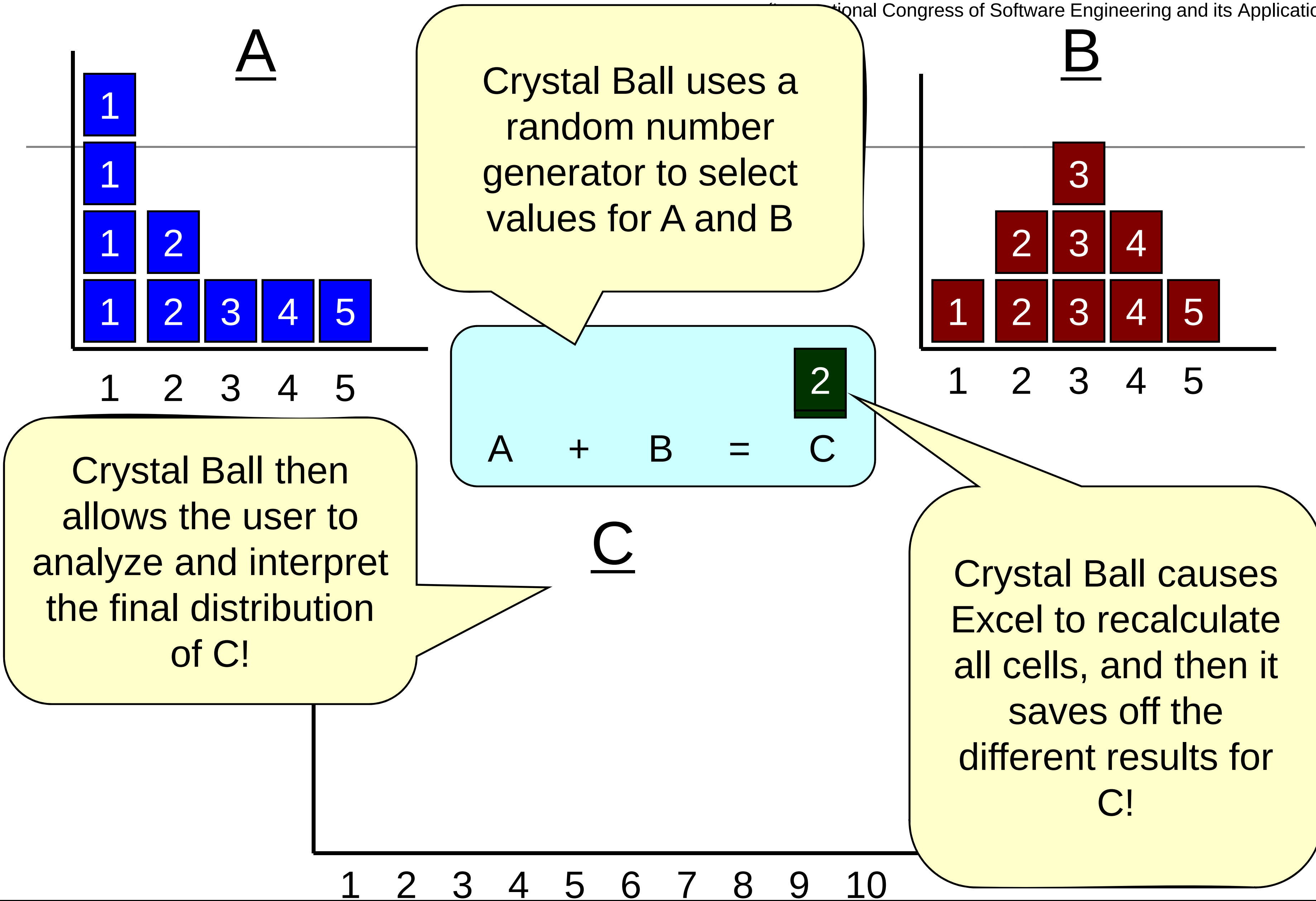


Monte Carlo Simulation Models Process Factors

We can identify process factors that have uncertain distributions of behavior

Then we can load them in a spreadsheet and calculate the predicted performance outcomes

The performance outcomes will also have distributions of behavior


A
1
1
1 2
1 2 3 4 5
1 2 3 4 5
Crystal Ball uses a random number generator to select values for A and B
B
3
2 3 4
1 2 3 4 5
1 2 3 4 5
2
A + B = C
Crystal Ball then allows the user to analyze and interpret the final distribution of C!
C
Crystal Ball causes Excel to recalculate all cells, and then it saves off the different results for C!
1 2 3 4 5 6 7 8 9 10

Developing Correlation and Regression Models

		Y	
		Continuous	Discrete
X	Discrete	ANOVA & Dummy Variable Regression	Chi-Square & Logistic Regression
	Continuous	Correlation & Simple Regression	Logistic Regression

Analytical Methods

Large Settings

- Large investment in discrete event process simulation models for complex processes
- Large collection of process performance models to deal with most phases and key activities/hand-offs

Small Settings

- Small regression equations
- Small probabilistic models
- A greater use of Monte Carlo simulation for real-time assessment of unbalanced risk
- A small number of process performance models
- Models built and operated within individuals

Group Exercise #5 (10 minutes)

Within your group, discuss the **types of analytical methods** that your projects within small settings would most likely use.

Document the types of analytical methods on your group flip pad

Be prepared to share some of these with the audience at large

CONTRASTING LARGE VS SMALL ORGANIZATIONAL SETTINGS:

TRAINING AND DEPLOYMENT

Training and Deployment

Large Settings

- Corporate deployment team
- Develop training internally or purchase expensive external training materials
- Hire a team of experienced deployment change agents
- Send waves of people thru external training

Small Settings

- Identify a few experts to receive training
- Identify a few consultants or external coaches to help when needed
- Hitch a ride on training and/or consulting that a larger organization is conducting (commercial or gov't agency)

Group Exercise #6 (10 minutes)

Within your group, discuss **the training and deployment** that your projects within small settings would most likely pursue. Identify the aspects of training and deployment that your projects would most likely be concerned with.

Document the ideas on your group flip pad

Be prepared to share some of these with the audience at large

CONTRASTING LARGE VS SMALL ORGANIZATIONAL SETTINGS:

SPONSORSHIP AND PARTICIPATION

Traditional Management Review Perspective

Management has come to realize that just looking at the customary lagging outcomes is like driving a car using only the rear-view mirror.

Excerpted from the SEI course called
“Understanding CMMI High Maturity Practices”

High Maturity Management Review Perspective

Management dashboards in High Maturity organizations include not only outcomes but leading indicators

- such as the controllable x factors used in process performance models.

Thus, management has asked for an additional 3-5 leading indicators for each traditional, lagging indicator used on dashboards.

Excerpted from the SEI course called
“Understanding CMMI High Maturity Practices”

A Change in Senior Management Behavior

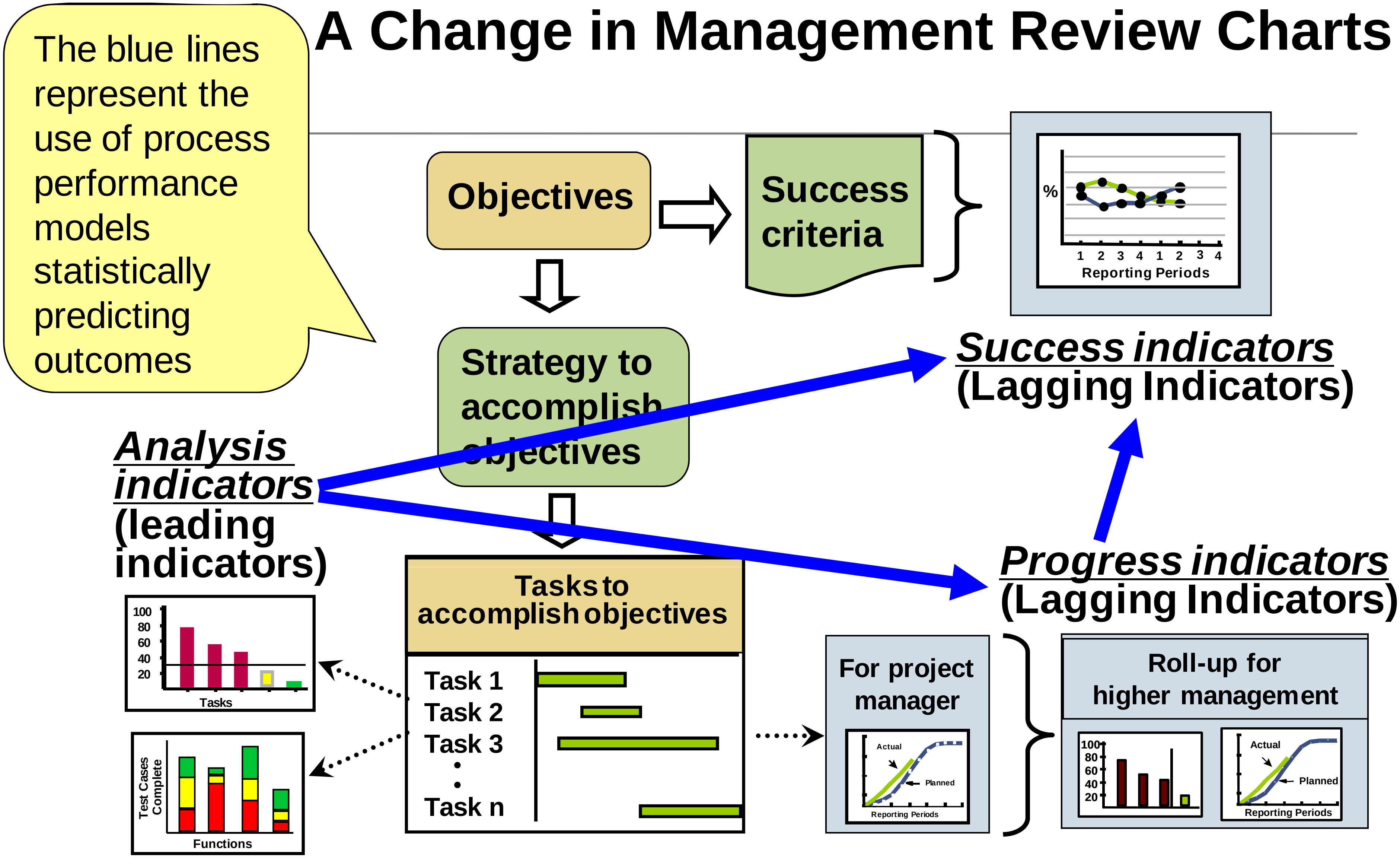
Before, management spent approx. 80% of each management review looking at the lagging indictors (e.g. the outcomes of cost, schedule and quality)

Now, in High Maturity, they spend approx. 80% of their time reviewing the statistical management of controllable x factors and the results of process performance model predictions.

The discussion is now primarily focused on how management can pro-actively take action based on performance models predictions!

Excerpted from the SEI course called
“Understanding CMMI High Maturity Practices”

A Change in Management Review Charts



Excerpted from the SEI course called
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Sponsorship and Participation

Large Settings

- Significant top-down sales pitch to executives and middle management is required
- Dedicated resources provide full-time support for key modeling activities
- Key process owners get involved but not average developer

Small Settings

- Top-down or bottom-up approaches can work
- Success will breed success (show early benefit)
- Most individuals will be involved with the basic modeling techniques
- A single person may serve as a coach for rest of team

Group Exercise #7 (10 minutes)

Within your group, discuss: 1) the challenges with **management sponsorship** and, 2) the **degree of team participation** that your projects within small settings would most likely experience.

Document the ideas on your group flip pad along with ideas on how you would prevent or mitigate these issues.

Be prepared to share some of these with the audience at large

NEXT STEPS

Ideas for Next Steps

Identify how to integrate a CMMI High Maturity approach with existing improvement methods *(specifically TSP/PSP provide a strong measurement culture to support process performance modeling)*

Identify and acquire the necessary training and/or skilled staff for CMMI process performance modeling *(consider an integration of certified CMMI-Six Sigma Belts in addition to certified PSP Developers and TSP coaches)*

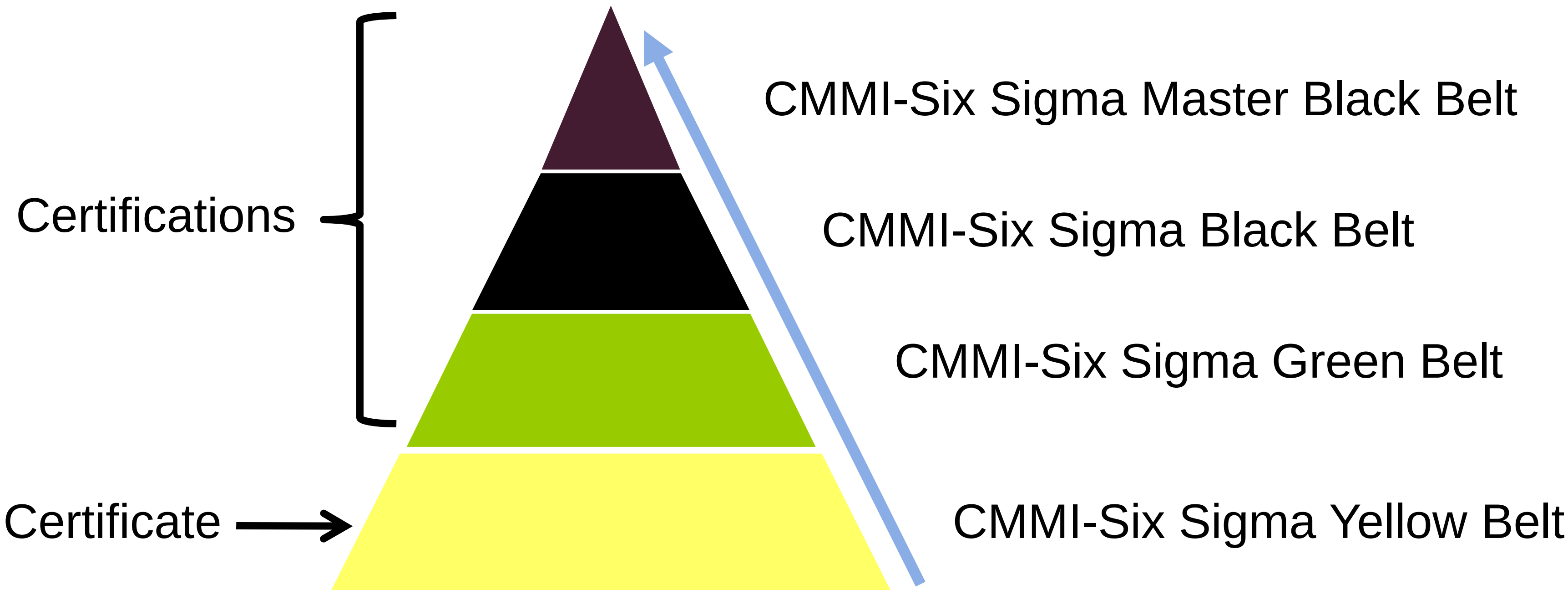
Hold necessary workshops to identify compelling business and project level performance and quality goals *(SEMA offers a jumpstart workshop on this)*

Develop process performance models and institutionalize their usage and maintenance *(SEMA offers hands-on coaching of this)*

SEI Measurement Curriculum

Course Title	
• Implementing Goal-Driven Measurement	• Yellow Belt
• Analyzing Project Management Indicators	
• Improving Process Performance Using Six Sigma	• Green Belt
• Designing Products and Processes Using Six Sigma	• Black Belt
• Living the High Life: A CMMI High Maturity Tutorial	
• Understanding CMMI High Maturity Practices	• Black Belt

SEI CMMI-Six Sigma Belt Certification Program



Preliminary Qualification Requirements

Education, Experience, Competency, and Skills Clusters	SEI Designation in Yellow Belt	SEI-Certified CMMI-Green Belt	SEI-Certified CMMI-Six Sigma Black Belt in CMMI	SEI-Certified CMMI-Six Master Black Belt
Prerequisite to enter qualification track	None	SEI CMMI-Six Sigma Yellow Belt	SEI CMMI-Six Sigma Green Belt	SEI CMMI-Six Sigma Black Belt
CMMI	Introduction to CMMI v 1.2	Intermediate CMMI : or pass the Intermediate Concepts for CMMI examination	Understanding CMMI High Maturity Concepts: or become certified HM Lead Appraiser	Participate as an Appraisal Team Member on Two (2) SCAMPI A or B appraisals CMMI-Six Sigma Strategies
Measurement and Analysis & Six Sigma	Implementing Goal Driven Measurement (IGDM) or complete the IGDM Exercise	Improving Process Performance Using Six Sigma (IPPSS)	Designing Process and Products using Six Sigma (DPPSS)	-Attend 1 Phase Transition Workshop -Lead a min of 1 Phase Transition Workshop mentored by a SEI Certified MBB
Electives: (Present evidence of completion)	Complete one course related to statistically based problem solving approaches	-	Show evidence of successful completion of one of the following SEI courses: -SEI Mastering Process Improvement - SEI Managing Technological Change - CMMI-Six Sigma Strategies	-Show evidence of Mentoring/Coaching Teams Training

Robert W. Stoddard II
Senior Member of Technical Staff
Software Engineering Measurement and Analysis (SEMA)
SEI, Carnegie Mellon University
Motorola-Certified Six Sigma Master Black Belt
ASQ Certified Six Sigma Black Belt
rws@sei.cmu.edu
(412) 268-1121

Software Engineering Institute | Carnegie Mellon